

Meta Analysis: The Effect of Realistic Mathematics Education (RME) Approach on Improving Students' Creative Thinking

Betseba Kariam¹, Suryo Widodo², Yuni Katminingsih³, Bambang Agus Sulistyono⁴

^{1,2,3,4} Department of Mathematics Education, Faculty of Health and Science, Universitas Nusantara PGRI Kediri, Indonesia

ARTICLE INFO	ABSTRACT
Published Online: 19 July 2025	Many studies have been conducted to examine the impact of the realistic mathematics education (RME) approach on improving students' creative thinking in Indonesia. The various findings from these studies have created a mismatch in assessment. Therefore, a meta-analysis study is needed to comprehensively assess its effect. Meta-analysis is a statistical method that collects and analyzes data from various studies in a quantitative way. The findings of this study show that RME has an influence on students' creative thinking. With an effect size of 0.89, it shows that the impact is very large according to Cohen's scale. Realistic Mathematics Education (RME) has a very large impact on increasing students' creative thinking. With an average effect size of elementary school (SD) equivalent worth 1.460 and junior high school (SMP) equivalent worth 0.649. However, when the two are compared the effect is greater at the elementary school level. As a result, this study shows that the realistic mathematics education (RME) approach is considered a more effective method in improving students' creative thinking when compared to traditional learning methods.
Corresponding Author: Suryo Widodo	
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I. INTRODUCTION

Education is very important in human life, consisting of a structured process that aims to improve the quality of life and advance humanity as a whole (Adila & Rodyyah, 2024). Education is essential for individual development, going beyond formal settings to encompass a variety of diverse learning contexts (Sutallhis & Novaria, 2023). Education has been an integral part of society for centuries. One of the main elements in education is the learning process, which plays a crucial role in improving the overall quality of education. Education is also defined as the learning process obtained by every human being to make that human being understand, understand, more mature, and critical in thinking. Education can be divided into several types, namely formal education, non-formal education and informal education (Triwiyanto, 2021). Mathematics is a subject that is taught to students through formal education at the elementary, junior high, and high school levels.

Mathematics is one of the subjects studied at every level of education in Indonesia. Mathematics education is a basic science that is very useful for human life. It is intended to

equip them with the ability to think logically, systematically analytically, critically, creatively, and the ability to work together (Gustiani&Puspitasari, 2021). The problem is that there are still many students who don't like math and think math is a boring lesson (Putri et al., 2023). This situation can affect students' learning achievement (Margiathi et al., 2023). Creative thinking ability is the ability to analyze something based on available data or information but also give birth to new concepts that are far more perfect and determine alternatives with various ideas that can be used to solve the problem (Siki et al., 2024). In creative thinking, a person will go through the stages of synthesizing ideas, also giving birth to new concepts that are far more perfect in planning the use of ideas, and implementing these ideas so as to produce something new and more perfect (Setiawan et al., 2024). (Setiawan et al., 2024) states that creative thinking is a variety of ways to see or do something that is characterized by four components, namely 1) Fluency (making various ideas; 2) Flexibility (ability to look forward easily); 3) originality (composing something new); 4) Elaboration (building

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something from other ideas). Elaboration (building something from other ideas).

The importance of creative thinking plays an important role in higher order thinking skills. That 2/3 of a person's creativity ability is obtained through education, the remaining 1/3 comes from genetics. Conversely, for intelligence, it applies that 1/3 of intelligence ability is obtained from education, the remaining 2/3 from genetics. This means that we can do a lot to improve someone's intelligence but we have many opportunities to improve someone's creativity (Katminingsih & Widodo, 2021).

Improving student learning outcomes requires the application of appropriate learning models, techniques, and methods. One alternative that can be used is the realistic mathematics education (RME) approach (Asdar et al., 2021). The realistic mathematics education approach is an approach to learning that uses real examples in daily activities, related to the problems and mathematical problems presented, so that students can more easily find and construct their own mathematical concepts in solving the problems to be worked on (Sohilait, 2021). This approach is also considered capable of raising students' interest in learning with a picture that creates direct experience that will build their own memories of the material to be learned respectively. The concept of learning with a realistic mathematics education approach is that students will be given ample opportunity to discover mathematical ideas and concepts in the exploration of various real-world situations and problems with adult guidance and gradually students can develop their knowledge towards mathematical understanding (Marni & Pasaribu, 2021).

Various studies have been conducted to assess the impact of the realistic education approach (RME) in improving students' creative thinking skills in Indonesia. Therefore, a study is needed to assess the effect of the realistic mathematics education approach on students' creative thinking skills in learning mathematics in Indonesia as a whole. The purpose of this study is to reduce discrepancies and confirm the truth of some previous research results. The appropriate method for this analysis is meta-analysis, a research approach that systematically and quantitatively examines existing studies to gain a deeper understanding of something (Sari & Tanjung, 2022).

II. RESEARCH METHOD

This research uses the meta-analysis method, which is a quantitative research approach that involves statistical techniques to summarize and synthesize the results of several similar studies. Meta-analysis is a type of research that collects and analyzes previous primary research that is quantitative (Palayukan et al., 2024). In conducting this meta-analysis, scientific journals were used as the main data source. The data were collected from online international journals that have been published and indexed in the Scopus database. The search process was conducted using the Publish

or Perish application, using the keywords "realistic mathematics education" and "creative". Articles that met the inclusion criteria were used as samples in the analysis.

This study followed the standard operating procedure (SOP) preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) as a reference in conducting meta-analysis. PRISMA SOP is a systematic guide designed to improve the transparency and quality of reporting in systematic review and meta-analysis research, as well as facilitate the structure of the research objectives roadmap (Martha, 2025). The PRISMA SOP is carried out through 3 stages, namely article search and retrieval, screening, and analysis. In the initial stage of searching for articles related to the realistic mathematics education approach, 200 articles were obtained, the articles were uploaded to the Mendeley application for data processing, 15 articles were deleted because they were duplicates, 40 articles were deleted because they were published more than the last 6 years, 35 articles were deleted because they were not in the field of mathematics studies. Then at the next stage, namely screening, several articles were deleted because they did not meet the inclusion and exclusion criteria so that only 7 articles were eligible for analysis. To make it easier to understand, the PRISMA flow diagram is presented.

Table 1. Table of inclusion criteria

No.	Inclusion criteria
1.	Sourced from google scholar and scopus databases.
2.	Published in 2020-2025.
3.	Related to the science of mathematics.
4.	The level of education at the elementary, and junior high school level is equivalent.
5.	Using quantitative research
6.	There is a comparison class (experimental and control)

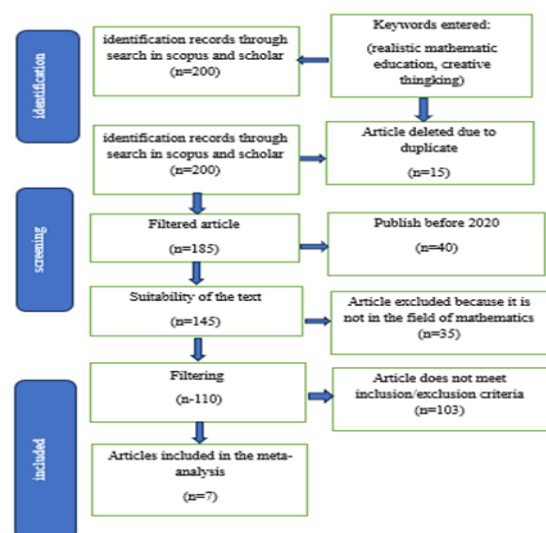


Figure 1. PRISMA diagram

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Seven (7), the data that has been collected is analyzed using a five-stage meta-analysis approach as outlined by (R. D. L. P. Dewi et al., 2024) . The first stage involved systematically formulating the research problem. The second stage involved collecting relevant data from studies that met the inclusion criteria. In the third stage, the primary studies were coded to extract important information required for analysis. The fourth stage involved a series of statistical analyses, including public bias testing, *effect size* calculation, heterogeneity testing, selection of the appropriate estimation model (fixed-effects or random-effects), hypothesis testing, and analysis of study characteristics as moderators. The fifth stage is the presentation of the analysis results in narrative and visual form. The entire statistical analysis process is supported by JASP software to ensure the accuracy and transparency of the results obtained.

Initial statistical analysis began with a publication bias test to ensure that the data used were free from bias and suitable for further analysis. To identify potential publication bias, funnel plots were used as a visual tool that can estimate any imbalance in the *effect size* distribution. The strength of publication bias is determined by the degree of symmetry of the *effect size* distribution in the funnel plot-the more symmetrical the distribution, the less likely there is to be publication bias. However, if the funnel plot showed asymmetry, a fail-safe N test was applied to provide a quantitative assessment of the potential bias that might affect the results of the analysis. If the value was $\frac{N}{(5k+10)} > 1$, the study was considered free from bias. Furthermore, the effect size was calculated with Hedges's g equation and classified with the cohen scale where the value= 0,2 indicates a small effect, the value between 0,21 – 0,50 indicates a medium effect, the value between 0,51 – 1,00 indicates a large effect,

and the value > 1,00 indicates a very large effect (YUNAWATI, 2024) .

The results of the calculation of the cohen's effect size value are interpreted with cohen's criteria (Katminingsih & Widodo, 2021) as follows.

No.	Es value	Category
1.	0 - 0,20	Very low effect
2.	0,21 - 0,50	Low effect
3.	0,51 - 1,00	Medium effect
4.	>1,00	High effect

After determining the effect size for each study, the next step is to test for heterogeneity by checking the value of *statistik – Q* dan nilai *p – value*. In addition to determining the estimation model, this test also aims to determine the combined effect size of all primary studies. If the value of *fp* < 0,05, then H_0 is rejected, which means that the effect size of each study is different (heterogeneous) and the estimation model chosen is the random effect model (Hadady & Mustafa, 2022) .

Furthermore, hypothesis testing is carried out by testing the value *p – value* of the Z statistic. H_0 rejection criteria if *p – value* < 0,05, shows a significant effect. The last test is the assessment of study characteristics by examining the average effect size value of each education level (V. R. Dewi et al., 2025) .

III. RESULTS

Based on the application of standard operating procedures (SOP) *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA), 7 primary studies were obtained that met the inclusion criteria and will be analyzed further. Information from the 7 studies is presented in Table 2.

Table 2. List of articles used in the studi

Code	Name	Title	Journal
A101	<ul style="list-style-type: none"> • Sina Ndiung • Sariyasa • Emilianus Jehadus • Ratih Ayu Apsari 	The Effect of Treffinger Creative Learning Model with the Use of RME Principles on Creative Thinking Skill and Mathematics Learning Outcome	International Journal of Instruction
A102	<ul style="list-style-type: none"> • Y Dwi Kurino • U Cahyaningsih 	The Effect of Realistic Mathematic Education towards Students' Learning Motivation in Elementary School	Journal of Physics: Conference Series
B201	<ul style="list-style-type: none"> • Rustam Effendy • Sury Adellia 	Investigating the effects of Realistic Mathematics Education on mathematical creativity through a mixed-methods approach	Indonesian Journal of Science and Mathematics Education
B202	<ul style="list-style-type: none"> • SYutaridho • Feli Ramury • Nurhijahl • Raden Fatah 	THE INFLUENCE OF INDONESIA'S REALISTIC MATHEMATICS EDUCATION APPROACH ON STUDENTS' CREATIVE THINKING ABILITY	Jambi University Scientific Journal of Applied Sciences
B203	<ul style="list-style-type: none"> • Rahmah Johar • Arta Maisela • Suhartati 	Students' creative thinking skills through realistic mathematics education on straight-line equation	Journal element

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B204	<ul style="list-style-type: none"> • D Ismunandar • F Gunadi • M Taufan • D Mulyana • Runisah 	Creative thinking skill of students through realistic mathematics education approach	Journal of Physics: Conference Series
B205	<ul style="list-style-type: none"> • U Royhana • A Widiatsih • I W W Atmaja • B J Septory 	Development of teaching materials based on realistic Mathematic education and its implementation in improving students' creative thinking skills on comparative material	Journal of Physics: Conference Series

The required statistical data were extracted from all these studies and are presented in Table 3.

Table 3. Recapitulation of data extraction results

Statistical Data							
Code	Experimental Class			Control Class			Effect Size
	Mean	SD	n	Mean	SD	n	
A101	67,84	10,87	51	58,8	9,98	50	1,12461128
A102	79,37	8.626	20	66,87	10,209	20	1,921748351
A201	28,75	7,750	32	28,69	6,537	32	1,0948705
A202	82	4,731	31	58	4,569	29	6,464611014
A203	65	21.8439	32	53	26.1504	30	7,6426605
A204	17,61	3,791	33	30,09	4,433	33	-4,070020511
A205	19.74	2.83	35	17.57	2.41	35	0,950744445

Information has been presented on data extraction from the primary study in which the statistical data is divided into 2 groups based on education level, namely: junior high school study group with codes A101, A102. and junior high school study group equivalent with codes B201, B202, B203, B204, B205.

The extracted data was tested for publication bias with the funnel plot in Figure 2. However, the shape is not symmetrical, so the fail-safe N (FSN) test is performed. With the formula $\frac{N}{(5k+10)} > 1$ Substitute the N and k values presented, $\frac{700}{5(7)+10} > 1$ so that the results obtained are $15.56 > 1$. This means that the 7 primary studies are included in the analysis that are free from publication bias and are suitable for use in further analysis.

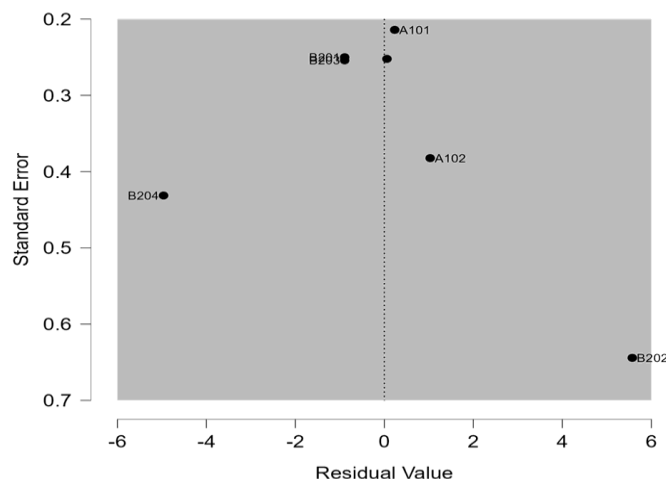


Figure 2. Funnel plot publication bias test

The next step is to calculate the effect size with a forest plot. Figure 3 shows that the effect size of each study is in a varied classification. There are 1 study with a very large effect, namely B202; 3 studies with a large effect size, namely A102, A101, B205; 2 studies with a medium effect size, namely B203, B201; 1 study with a small effect size, namely B204.

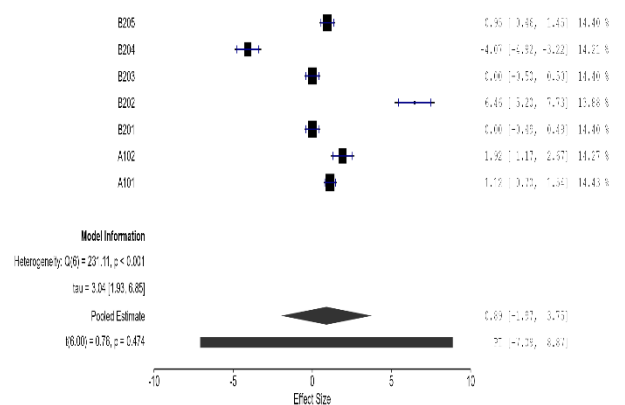


Figure 3. Calculation of effect size forest plot

Furthermore, the heterogeneity test is carried out and determines the estimation model to obtain the overall effect size. From table 5, it is known if the p value is <0.001 with a significant level of 95%. Then the value $p < 0.05$ is met, so H_0 is rejected, which means that the effect size of each study is different (heterogeneous) and the selected estimation model is the random effect model.

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Table 4. Heterogeneity test

Fixed and Random Effects

Residual Heterogeneity Test

Q_e	df	p
231.108	6	< .001

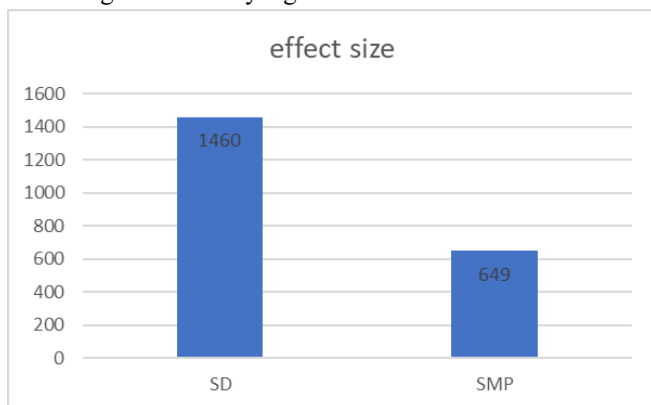
Then conduct hypothesis testing with the random effect model, it can be seen in Table 6 that the p-value of the Z statistic is < 0.001. Then the H0 rejection criterion if $p - value < 0.05$ is met, which means that the application of the Realistic Mathematics Education (RME) approach learning model has a significant effect on students' mathematics learning creativity than the conventional learning model.

Table 5. hypothesis test

Meta-Analytic Estimates

	Estimate	95% CI		95% PI	
		Lower	Upper	Lower	Upper
Effect	0.892	-1.968	3.752	-7.086	8.870
τ	3.044	1.934	6.847		
τ^2	9.265	3.740	46.881		

From the heterogeneity analysis, it can be seen that there is variation in all the studies, so the last step taken was to assess the characteristics of the studies with special attention to the secondary school education level. Based on Figure 4, the average ES value at the primary school level is 1.460, which indicates a highly significant effect. Meanwhile, the average ES value for the junior secondary school level is 0.649, indicating a moderately significant effect.



IV. DISCUSSION

This study used the meta-analysis method to determine the effect of the Realistic Mathematics Education (RME) approach on improving students' creative thinking. To determine the effect, it is necessary to conduct statistical analysis with the help of JASP software. The analysis used raw data from 7 study data that passed the Prisma SOP. Based on the results of the statistical analysis above, the bias test

stage of 7 primary studies is included in the analysis that is free from publication bias and is suitable for use. So that it can continue to the next stage, namely the calculation of the effect size which results in a variable effect size, namely 1 study states that it has an effect on the effect size of the study. varied, namely 1 study stated that it had a very large effect, 3 studies stated that it had a large effect, and 2 study data that has a medium effect size. and 1 studie stated that it had a small effect.

Furthermore, the heterogeneity test states that 7 study data are heterogeneous so that the selected estimation model is the random effect model. Next, the hypothesis testing stage states that there is a significant effect of the Realistic Mathematics Education (RME) approach on increasing students' creative thinking, which is relevant to several previous studies.

The final stage is testing the characteristics of the research which shows that there is a very significant impact at the school level, both at the elementary and junior high school levels. However, if the two are compared, the impact is greater at the elementary school level (SD) than junior high school (SMP). This finding is in line with several previous studies (Munawwaroh, 2025).

V. CONCLUSION

Based on the level of education, the average effect size of elementary school (SD) is 1.460 and junior high school (SMP) is 0.649, which means that both at the elementary and junior high school levels. This means that both at the elementary and junior high school levels, the realistic mathematics education (RME) approach has a very large

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effect on increasing students' creative thinking. However, if the two are compared, the effect is greater at the elementary school level.

Based on the results of the overall analysis, the average effect size of the 7 study data is 0.89, meaning that the realistic mathematics education approach (RME) has a very large effect on increasing students' creative thinking. So that learning mathematics using a realistic mathematics education approach (PMR) is very effective and suitable for the learning process compared to conventional learning models.

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